AIRPHOTO INTERPRETATION OF ENGINEERING SOILS OF CASS COUNTY, INDIANA

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NO. 29

by

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&

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Joint Highway Research Project

PURDUE UNIVERSITY
LAFAYETTE INDIANA

Final Report

AIRPHOTO INTERPRETATION OF ENGINEERING SOILS OF

CASS COUNTY, INDIANA

TO: K. B. Woods, Director
Joint Highway Research Project

November 19, 1959

FROM: H. L. Michael, Assistant Director
Joint Highway Research Project

File: 1-5-2B-32
Project: C-36-51B

The attached report, entitled "Airphoto Interpretation of Engineering Soils of Cass County, Indiana," completes a portion of the project concerned with Engineering Soils mapping from aerial photographs. The report was prepared by R. E. Becker, former research assistant, and P. T. Yeh, Research Engineer, Joint Highway Research Project.

The soils mapping of Cass County was done primarily by airphoto interpretation. However, the soil borders are justified by field investigation. To increase the value of the county engineering soil maps, the major soil types were sampled and tested in the soil laboratory. The soil testing data included grain-size analysis, plastic limit, liquid limit, optimum moisture content for maximum dry weight from standard Proctor test, and CBR. The major soils were classified under the USCS and BPR system. All the test data and the appropriate classification are listed in a table on the map.

An ozalid print of the engineering soils map is included in the back of the report.

Comments and suggestions as to the value of soils maps which incorporate soil test data would be appreciated. It is anticipated that at the next board meeting a formal proposal to increase the scope of the mapping project to include laboratory test data will be submitted.

Respectfully submitted,

Harold L. Michael

Harold L. Michael
Assistant Director

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OF

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by

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and
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Purdue University
Lafayette, Indiana

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R. E. Becker and P. T. Yeh

INTRODUCTION

The mapping of the engineering soils of Cass County was accomplished using 7" x 9" aerial photographs having an approximate scale of 1:20,000. These airphotos were taken during the fall of 1938 and summer of 1939 in connection with the mapping program of the United States Department of Agriculture. Prints were purchased from the Agricultural Adjustment Administration (now Commodity Stabilization Service, Performance and Aerial Photography Division, USDA). Certain ambiguities in the photo patterns which resulted from extremely contrasting photography and seasonal changes in soil moisture during the various periods of photography (Figure 1) were resolved by comparison with a more recent series of photographs taken during July 1957. The latter series, however, was not available until the photo interpretation program was nearly completed.

Photo interpretation of the land forms and soil textures of this region was accomplished in accordance with accepted principles of observation and inference (1). Field trips were made to the area for the purposes of resolving ambiguous details, correlating airphoto patterns with soil textures, and to secure soil samples. Test data included herein were obtained from laboratory testing accomplished on these samples, unless otherwise noted.

Certain geological events have been hypothesized to account for development of the present land features. It is almost certain that a

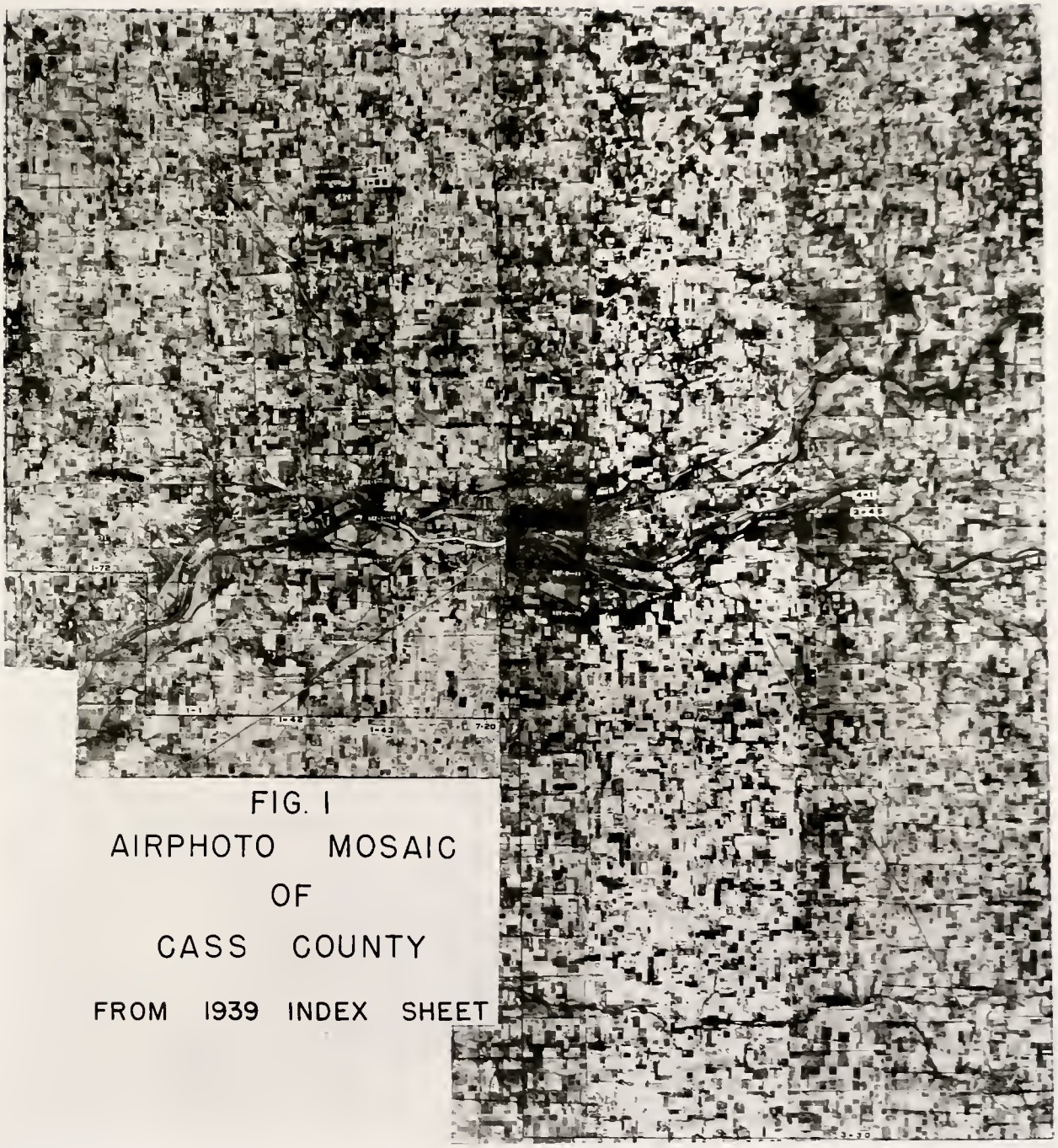
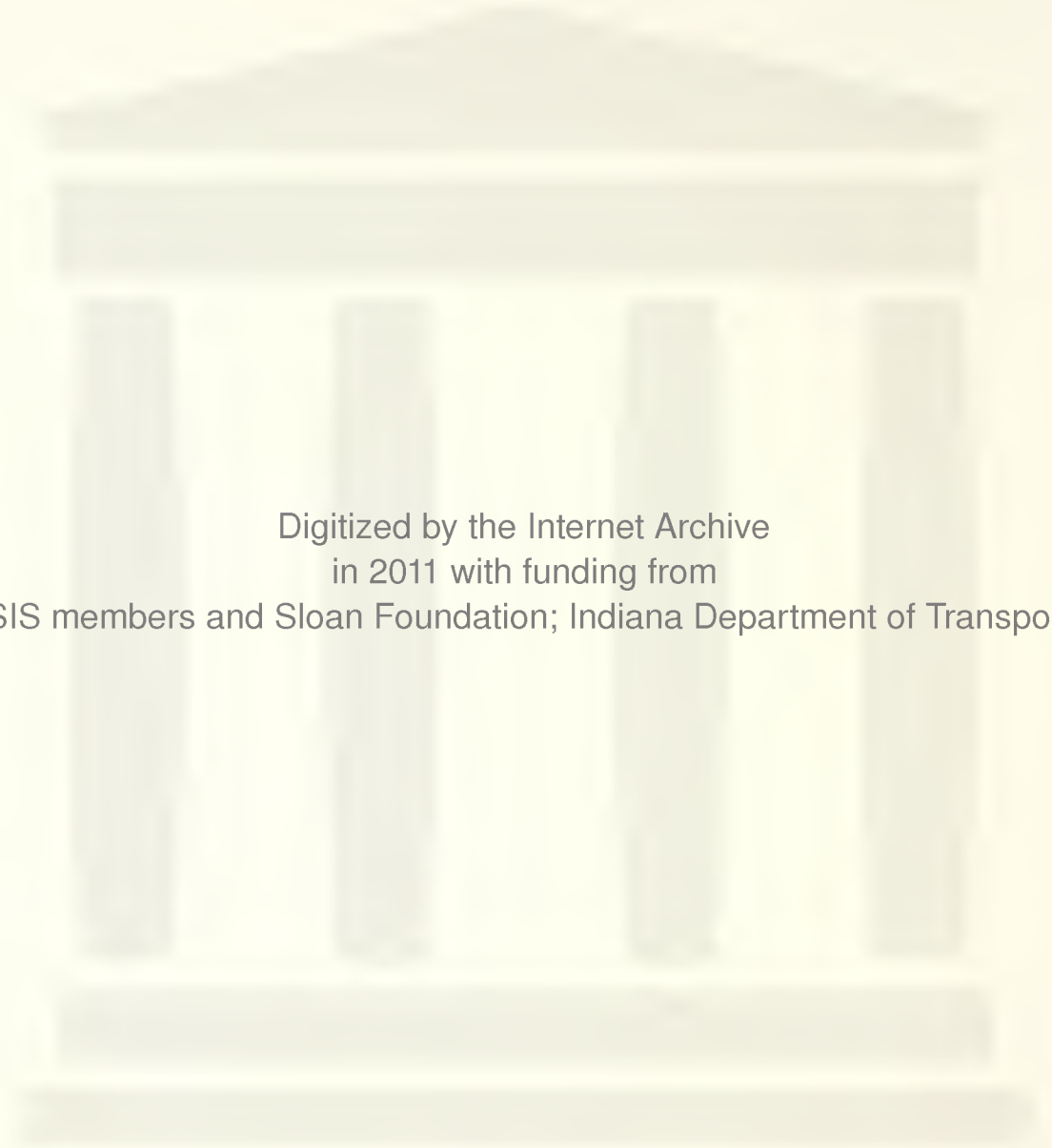


FIG. I
AIRPHOTO MOSAIC
OF
CASS COUNTY
FROM 1939 INDEX SHEET



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detailed study of glacial geology in this region would provide a much more nearly complete picture than is given herein, which would be useful in developing a subsurface concept of glacial features beneath the sand dune deposits in the western and central portions of the county. Likewise, evaluation of the influence of the buried Teay's River valley in controlling drainage and ground water resources through the central part of the county would be useful from an engineering standpoint in consideration of ground water, foundations, and the like.

Standard mapping symbols developed by the staff of the Airphoto Interpretation Laboratory, School of Civil Engineering, Purdue University, were employed to delineate land forms and soil textures. The text of this report largely represents an effort to overcome the limitations imposed by adherence to a standard symbolism.

An approach towards better utilization of Engineering Soils Maps of Indiana has been made with the inclusion on the map of laboratory classification and test data for the principle soil types represented within this county. Certain soil types, of obviously inferior engineering qualities, were not sampled but were indicated on the attached map. These soils include principally organic soils such as muck, peat, and highly organic lacustrine soils which are of only limited extent.

Liberal reference was made to the Soil Survey of Cass County, 1957, prepared by the Department of Agronomy, Purdue University, and Cartographic Division, Soil Conservation Service, USDA (2). The agricultural soils map was found to be generally reliable within the scope of agricultural soil classification, although not necessarily compatible with the concept of physiographic soil groupings which forms the framework for this report.

In many instances the agricultural soils map did provide a convenient endorsement of the photo interpreter's judgment.

INTERPRETATION OF AREA

General

Cass County occupies about 415 square miles in north central Indiana, as noted on Figure 2. Its principle city and county seat, Logansport, is located centrally within the county at the confluence of the Wabash and Eel Rivers. In this favorable position the city has an important role as a transportation and commercial center of the surrounding region. It is served by two principal federal-aid highways, U. S. Nos. 24 and 35, and three state routes. Two railroads also serve the community.

Land use within the county is principally devoted to farming, with about 65.3% of the total area reported under cultivation in 1949 (2). Much of the uncultivated portion, including woodland and slopes unsuited for cultivation lies within the morainic regions bordering the Wabash and Eel Rivers on the north.

A population of 38,793 inhabitants resided within the county, with 21,031 reported for Logansport alone, according to the 1950 census (3).

Natural vegetation consisting of dense readiduous forest originally covered most of the county. In areas where cultivation has proceeded, only occasional woodlands remain, largely in areas characterized by high water table and waterlogged soil conditions. Though the county once contained abundant ponds and marshes, an aggressive program of artificial drainage has erased all but a few small bodies of standing water from the scene. Even Lake Cicott, the largest lake in the county, which was reported in 1894 to measure one-mile in its east-west dimension, has diminished to a length of barely 1/3 mile in response to lowering of the regional phreatic surface (4).

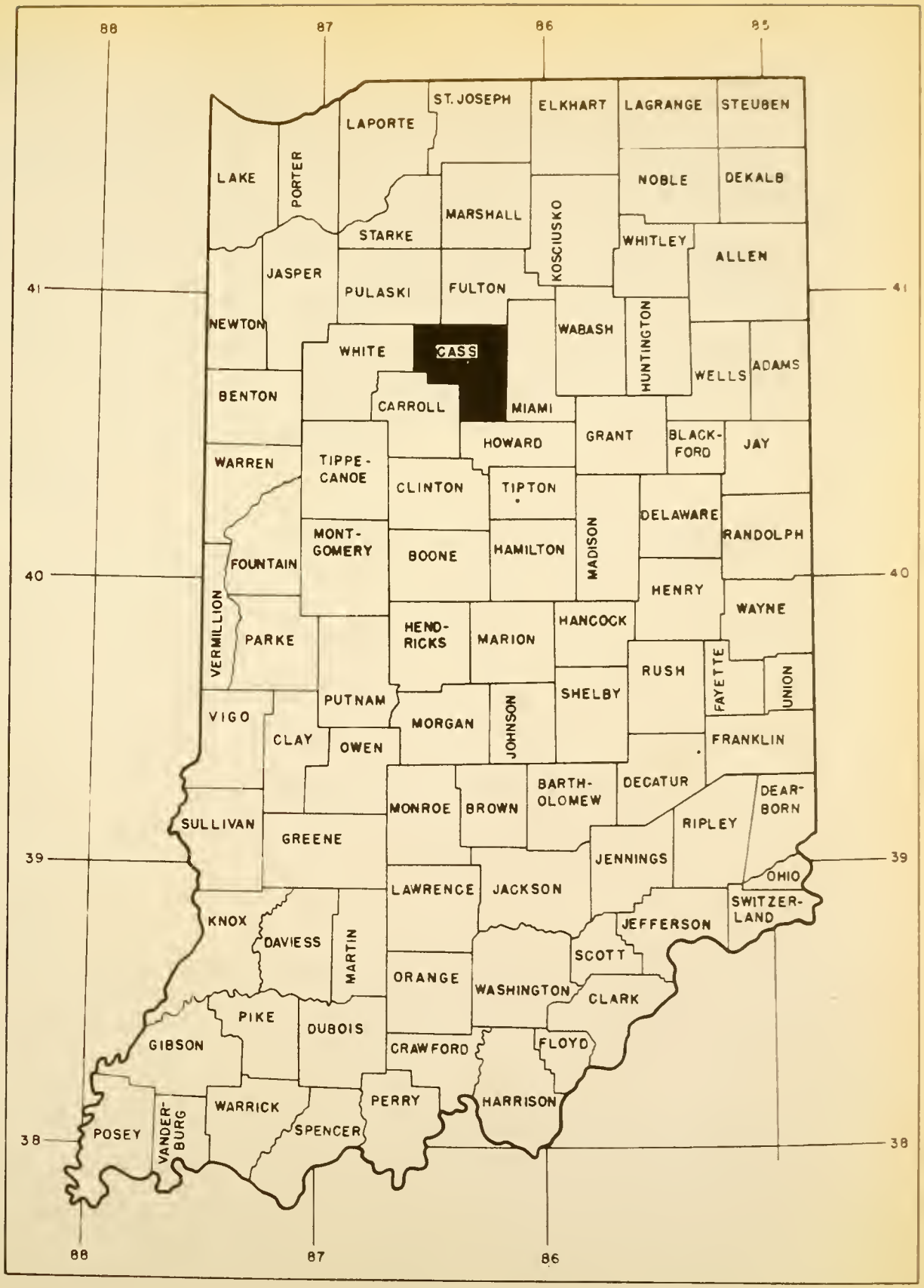

FIG. 2. LOCATION MAP OF CASS COUNTY

Climate

The climate of this region is described as a "humid, middle-latitude, continental climate in the battleground of the polar and tropical air-masses" (5). The introduction of polar continental air masses with those from a high-pressure region in the mid-Atlantic area creates highly variable weather conditions. Ample precipitation throughout the year is accentuated during the summer months. A climatic summary is presented in Table 1. It will be observed that seasonal temperature variations are great, and the winters are severe.

Physiography

Two major physiographic sections of the Central Lowland province, as delineated by Fenneman, are represented within Cass County (7, p. 69). North of the Wabash River, the lobate moraines and the associated features are classified as the Northern Moraine and Lake region (7, p. 66). This region is further subdivided into the Kankakee Lacustrine Section, along the western border of the county, and the Steuben Morainal Lake Section. The upland region south of the Wabash River is classified as the Tipton Till Plain (7).

Topography

Topography is a major criterion by which land forms are recognized, and therefore deserves some consideration in a discussion of engineering soils.

Within this county, altitudes vary from a maximum of 825 feet to a minimum of 550 feet (7, p. 81) with local relief seldom exceeding 120 feet. The maximum gradients and elevation differences occur along the Wabash River valley walls, where rather steep ascents are encountered

TABLE I

NORMAL MONTHLY AND ANNUAL TEMPERATURE AND
PRECIPTITATION AT LOGANSPORT, CASS COUNTY, INDIANA

Month	Temperature *			Precipitation		
	Mean °F	Absolute Maximum °F	Absolute Minimum °F	Mean Inches	Total Driest Year Inches	Total Wettest Year Inches
January	25.2	69	-25	2.48	.45	6.60
February	26.3	69	-24	2.08	1.37	3.50
March	37.8	87	- 3	3.13	.95	1.80
April	50.8	91	15	3.88	.88	2.45
May	62.2	101	28	4.36	2.38	7.50
June	71.2	103	35	4.46	1.62	12.16
July	75.4	106	43	3.62	.62	5.13
August	72.8	105	41	3.30	2.00	1.76
September	65.8	102	30	3.58	3.50	1.43
October	53.2	92	18	3.26	2.50	6.55
November	40.6	80	3	2.86	3.77	1.35
December	29.2	70	-15	2.12	4.54	4.34
Year	50.9	106	-25	39.13	24.58 (in 1856)	54.57 (in 1949)

* Recorded at elevation of 590 ft.
Average temperature based on a 35-year record, 1896 to 1930; highest and lowest temperatures from a 35-year record, 1896 to 1930.

between the flood plain and the uplands over a series of discontinuous terraces. The minimum altitude of 550 feet occurs in the southwestern part of the county where the Wabash River leaves the county.

The vast region south of the Wabash River is included in the Tipton Till Plain. This is a broad, flat to gently undulating surface of almost negligible relief, except in the vicinity of the streams which dissect the area. The elevation at Walton, near the center of this region, is 754 feet.

A more varied topographic expression is encountered north of the Wabash River. A broad zone of hilly, broken landscape adjacent to the river valley extends across the county in an east-west direction, and marks the position of the Packerton Moraine. It varies in width from 2 to 7 miles.

East of Logansport between the confluence of the Wabash and Eel Rivers, a rugged hilly, ridge-like extension of a moraine occurs which has been separated from the main morainic features by the valley of the Eel River and its adjacent glaciofluvial terraces. This moraine may also be an extension of the Union City Moraine from the south. Within this moraine, adjacent to the Wabash and Eel Valleys, numerous small streams have developed deeply incised gully systems, which further accentuate the rugged character of the terrain. Slopes having gradients between 6% and 15% are commonplace within this region.

Along the Wabash and Eel River valleys, numerous terrances occur at various levels between the streams and the uplands. Several of these terraces are masses of resistant limestone reef formations which have been separated from the adjacent terraces and the upland by abandoned

stream channels. Most of the terraces have a level to gently undulating topography and appear as benches in the broad river valley.

An extensive region assigned to the Kankakee Lacustrine section occupies the northwestern and western part of the county. The uniformly level surface here is somewhat modified by encroachment of sand dunes along the county's western boundary. In the southern portion of this region, around Lake Cicott, the dunes, which may attain heights greater than 30 feet, have obliterated the moraine contact. The elevation at Lake Cicott is 695; that at Royal Center, is 727 feet.

East of this Kankakee Lacustrine section, which is principally the result of glaciofluvial action, a sag-swell topography becomes prominent. This is the weakly developed southern portion of the Maxinkuckee Moraine, which is somewhat more prominent in Fulton, Marshall, and St. Joseph Counties to the north. This moraine lacks the ridge-like characteristics usually ascribed to terminal moraines, and is only recognized by its contrast to the extremely level plain immediately to the west.

Eastward of the Maxinkuckee Moraine and extending to the Packerton Moraine is a ground moraine region which is characterized by a sag-swell surface having only lightly less relief than the Maxinkuckee Moraine. The highest elevation in the county, 825 feet, occurs within this region, near Metea. Slopes within this sag-swell region may exceed 10% with an average local relief of about 20 feet throughout much of the area. Road cuts are rare, yet the topography has a distinctly hilly aspect.

A moderately level ground moraine is located northeast of Metea. Slopes throughout this area are generally less than 2%.

A restricted outwash plain is located at the southwest edge of the afore-mentioned ground moraine. It is characterized by somewhat more rolling terrain enchancing numerous small infiltration basins.

Another local outwash plain which has a subtle topography occurs within the Packerton Moraine east of Crooked Creek. It is about 10 feet below the surrounding moraine.

Drainage Features

The Wabash River and its tributaries drain almost all of the county as shown in Figure 3. A considerable portion in the northwest, including the area around Royal Center, is drained in a northwesterly direction by tributary streams of the Tippecanoe River. This region, including the outwash plains along the western flank of the Maxinkuckee moraine, shows a rather striking linear trend in the gullies, ditches, and muck channels towards the west and northwest. This drainage divide is rather convincing evidence of the existence of the Maninkuckee Moraine in this region, where topographic manifestations of a moraine are not clearly obvious. Within the northern portion of the Maxinkuckee Moraine, the drainage also trends towards the northwest, via the tributaries of Indian Creek.

The watershed of Crooked Creek occupies an area which is bounded by the Maxinkuckee Moraine on the northwest, the Packerton Moraine on the south, and an intermorainic ground moraine and outwash plain on the north and east. The stream follows a westerly course through a low, intermorainic region of muck channels, lacustrine clays, and generally subdued topography until it penetrates a more broken terrain of granular drift in the southern extremities of the Maxinkuckee Moraine. The stream course has been considerably deranged presumably through channel filling.

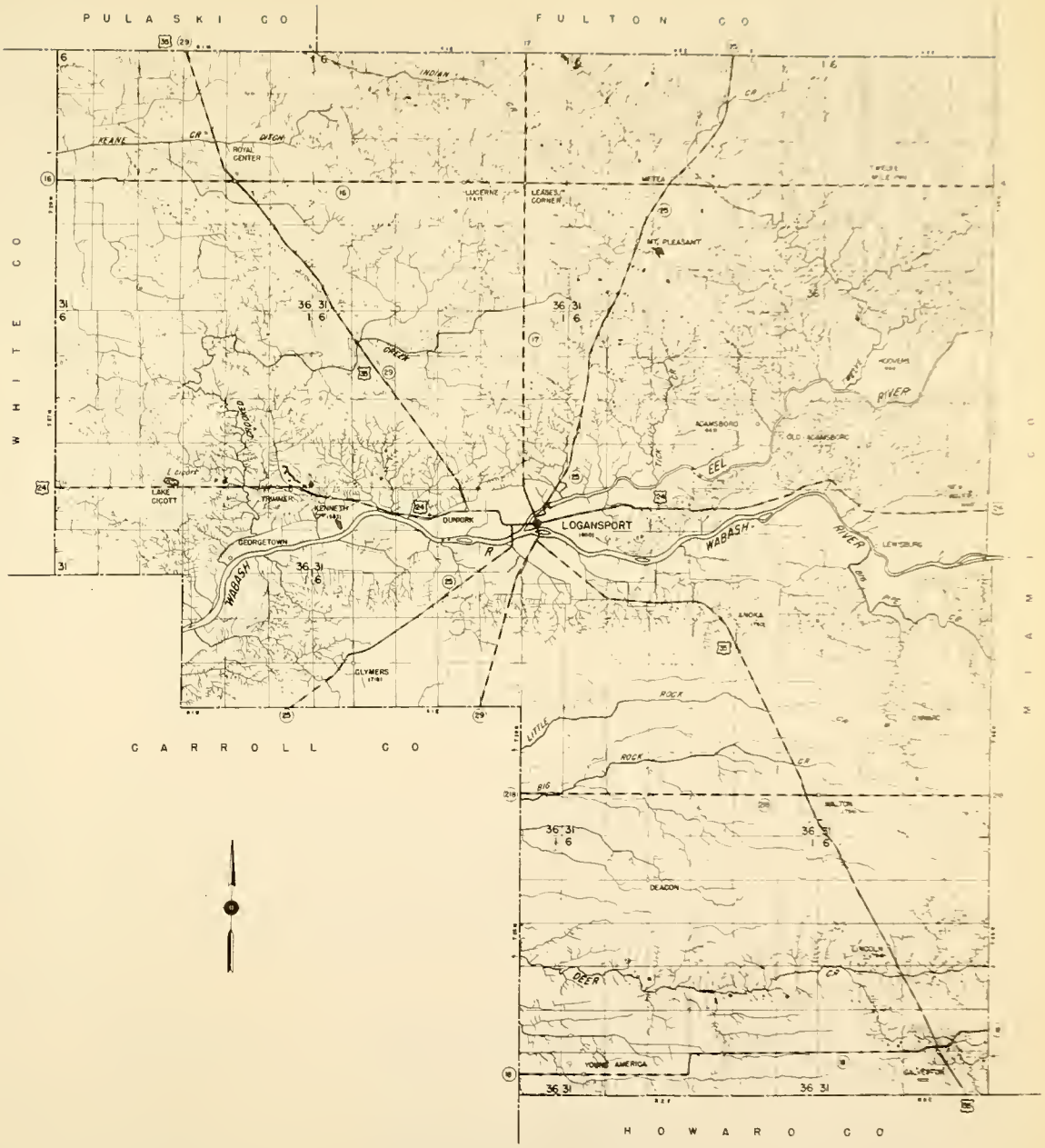

FIG. 3 DRAINAGE MAP OF CASS COUNTY, INDIANA

From a location where the stream formerly debouched upon a coarse-granular outwash plain south of Royal Center, the channel turns sharply southward, and strikes a well controlled, intrenched course through granular materials of the Packerton Moraine until it reaches the Wabash Valley near Georgetown.

The streams which drain the Tipton Till Plain flow in a westerly direction and empty into the Wabash River in Carroll County. These streams follow the westerly dip of the underlying Paleozoic sediments. This area is imperfectly drained and many man-made ditches have been constructed to improve drainage. Deer Creek and tributaries of Big Pipe Creek are the only natural drainageways in this area.

Geology

The bedrock formations of Cass County are composed of Paleozoic strata of Devonian and Silurian periods. The bedrock formations are covered with a mantle of glacial drift which varies in thickness from a few feet to more than 200 feet. Outcrops of bedrock occur where the major streams have cut through the mantle of the glacial drift, as along the Wabash River and its larger tributaries.

The following geological divisions have been recognized in well records (8, p. 47).

Quaternary - - - -	clays, sands, gravels (recent) sands, gravels, clays (pleistocene)
Devonian - - - - - -	shale (New Albany) limestone (Sellersburg, Jeffersonville) sandstone (Pendleton)
Silurian - - - - - -	limestone (Huntington, etc.) shale (Mississinewa)
Ordovician - - - - -	limestone, shale (Richmond) limestone (Trenton)

AIRPHOTO INTERPRETATION OF SOIL AREAS

The soils of Cass County include deposits of glacial, glaciofluvial, lacustrine, and alluvial origin. Many of the lacustrine and glaciofluvial materials have been modified by wind, so that eolian features superimposed over materials of other origins create complex airphoto patterns.

GLACIAL DEPOSITED MATERIALS

The entire county was covered by continental glaciers, therefore, the surface soils of Cass County are chiefly developed on glacial drift. The various deposits are discussed as follows:

Moraines

Moraines represented within Cass County include the Maxinkuckee Moraine and the Packerton Moraine. These morainic belts apparently converge in the western part of the county in the vicinity of Crooked Creek. Also there is a dissected ridge-like region between the Wabash and Eel Rivers. It seems to be the extension of the Union City Moraine from the south.

(1) Maxinkuckee Moraine

The Maxinkuckee Moraine within Cass County is part of an interrupted morainic belt which extends southerly, from South Bend, in St. Joseph County, to a junction with the Packerton Moraine in western Cass County. The moraine is topographically prominent in its northern reaches, but within Cass County, only that portion near the junction with the Packerton Moraine demonstrates appreciable relief. Since there is no definite break between the Maxinkuckee and Packerton moraines at the junction, the morainic area west of Crooked Creek is discussed under the Maxinkuckee Moraine in this report.

The northern portion of the moraine in Cass County is composed principally of fine-textured parent materials (C-horizon), notably sandy silts with numerous glacial erratics (boulders) and a clay content sufficient only to give the parent materials a plasticity index of less than 10%. The surface is rolling, hummocky terrain. Where numerous northwest flowing streams and gullies have breached the moraine, a rounded, knobby appearance has developed the major portion of the region, however, is characterized by an accentuated sag-swell surface. A weakly developed drainage pattern with numerous infiltration basins is evidence of the permeable nature of the sandy silt materials.

The surface soils or top soils (A-horizon) are about 12 inches in thickness and consist mainly of silty sand. Frequently a blanket of sand is present on the surface. The sand is derived from the adjacent outwash and sandy drift areas to the west. The subsurface soils or B-horizon within the northern region demonstrate slightly more plasticity and clay content than the parent material. The parent soil is usually encountered at depths ranging from three to four feet, although in locally depressed areas the depth may be greater. A typical example is shown at site No. 16. The clayey sand B-horizon which contains 48.1% of sand and 45.8% of fines has a LL (liquid limit) and PI (plastic index) of 26.4% and 13.1% respectively. The C-horizon taken from 4 to 6 feet below the surface reveals 45.6% of sand and 48.9% of fines. However, the liquid limit as well as the plastic index are reduced to 15.7% and 2.0% respectively. This silty sand parent soil has a CBR value of 22.4 and is much stronger in supporting power than the B-horizon

(with a CBR value of 8.6). The subsoil is classified as SC and A-6 (3) by the USCS (Unified Soil Classification System) and BPR (Bureau of Public Roads) classification respectively. SM or A-4 (3) soil is the classification of the parent material of the area.

Soil series encountered in this region typically include sandy phase members of the Miami, Metea, Crosby, and Brookston series. A few small deposits of the granular Bellefontaine series occur, and have been exploited as coarse aggregate sources. Several localized areas mapped as Colona sands by the agricultural soil survey should be regarded more properly as concentrations of wind-blown sand, rather than the glacial-deposits connoted by the series name (see test data of site No. 14).

In the southern portion of the Maxinkuckee Moraine in Cass County, coarse granular materials become prominent. The deranged pattern of Crooked Creek in this vicinity implies its origin as a meltwater channel which carried the torrential meltwaters from a receding ice front through the terminal moraine. Where the stream debouched upon the outwash plain immediately in front of the moraine it dropped its load of coarse water-worked debris, which soon effectively clogged the channel in the region of the moraine, and caused diversion of the outflow in a southerly direction. Repeated cycles of this process served to remove most of the fine-grained materials from the glacial drift within the moraine, and to deposite the outwash materials adjacent to the Crooked Creek channel. It seems likely that this process was particularly effective in this vicinity due to the proximity of

The Packerton Moraine along with southern flank, which may have formed as a barrier to the escape of meltwaters southward.

The development of the Maxinkuckee Moraine within Cass County reaches its zenith in the coarse granular materials at this southern portion. Along Crooked Creek and near Cicott Lake, stratified deposits of sands and gravels in exposures as much as 50 feet thick are in evidence; these are principally soils of the Bellefontaine series. A typical kettle-kame surface is developed within this area, and drainage is accomplished internally rather than through the development of a gully system, for the most part. Numerous infiltration basins give evidence of the high permeability and excessive internal drainage in this area.

Over much of this region the surface features have been modified by sand dunes swept up from the Kankakee outwash region to the west. These dunes are either of the typical crescent-shaped form or are long ridges, as much as a mile in length, closely resembling eskers in shape and form.

These sand dune deposits belong to the Plainfield series, although occasionally they are designated as Colma sands. The underlying and adjacent materials are frequently the coarse granular Bellefontaine series or sandy silts of the Miami series.

The southern most part of the moraine near Crooked Creek is a rugged, highly dissected, plateau-like region. The controlling topographic influence is due to the proximity of the valleys of the Wabash River and Crooked Creek which are well intrenched below the moraine crest. Numerous deep, steep sided gullies have been cut

well back into the moraine uplands, despite the permeable nature of the silts, sands and gravels which occupy this region. The gravels of this area are loosely compacted, and somewhat more susceptible to erosion than the adjacent sands and silts. Figure 4 illustrates the airphoto pattern typical of the gully erosion in the gravels that form the moraine.

The moraine deposits in this area chiefly belong to the Bellefontaine and Miami series; with but a minor extent of Russell soil located along the valley walls.

(2) Packerton Moraine

The Packerton Moraine extends across the county on the north side of the Wabash River in a broad southwest trending zone which occupies about a third of the county area. It varies in width from 1.5 to 5 miles. It is bounded on the south by the steep-walled Wabash River valley, and on the west by encroaching sand dunes of the Kankakee section and the indefinite junction with the Maxinkuckee Moraine. A chain of muck channels and intermorainic lacustrine deposits in the westward trending portion of the Crooked Creek drainage system served to delineate the irregular northern boundary of this moraine in the north central portion of the county. The moraine is characterized by extreme variability in the texture of its materials, so that accurate generalities are difficult to come by.

The western most section in the vicinity immediately east of Crooked Creek has a unique drainage pattern and topography as shown in Figure 5. Well-dissected, sharp crested hills and ridges are

FIG. 4 EROSIONAL FEATURES OF THE GRANULAR MORAINE

NOTE THE DEEP V-SHAPED GULLIES ON THE UNPROTECTED SLOPES

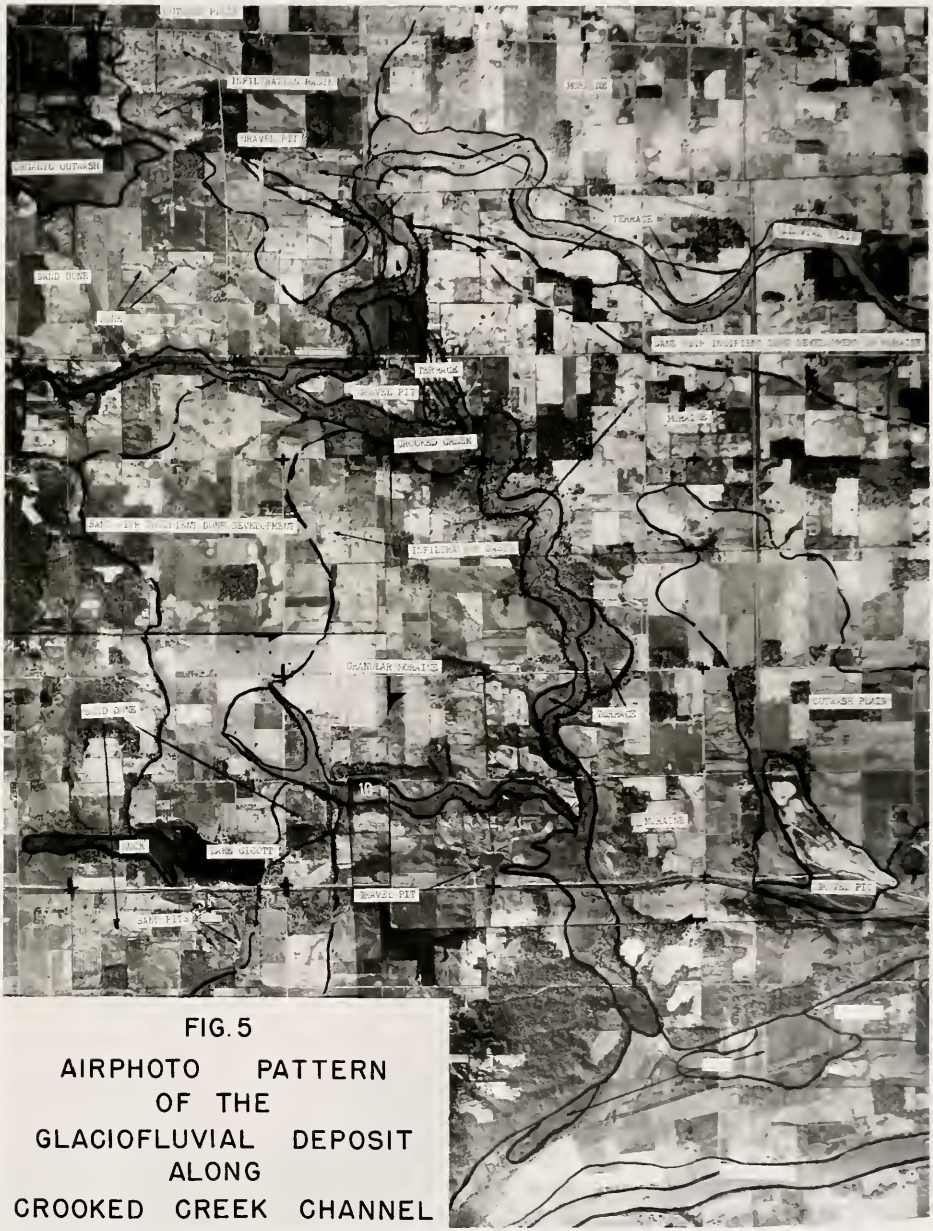

FIG. 5

AIRPHOTO PATTERN OF THE GLACIOFLUVIAL DEPOSIT ALONG CROOKED CREEK CHANNEL

found along the Crooked Creek valley wall and the rim of a local outwash basin to the east. On the upland the surface appears to be smooth with numerous small infiltration basins. The drainage pattern suggests that the sand silt surface material is underlain by porous material.

The soils of this region are designated principally as the Bonsall silt loam. Field inspection, however, disclosed the surface soil is sandy and silty in texture. Granular materials are found exposed on the flanks of the hills and ridges along the valley walls. The granular nature of this area is best revealed in the gravel pits. The grain size distribution is believed to be similar to that of test site No. 12.

A different aspect of topography and materials prevails within the central portion of the Packerton Moraine. Drainage features reflect a dendritic pattern development typical of more uniform and finer materials than those to the west. The moraine surface presents a uniform, rolling landscape, in contrast to the more severe, broken landscape to the west. A noticeably sandy texture is conspicuous in the surface soils, but the dune development is not present in this section. Likewise, granular aggregate sources are lacking. Limestone outcropping overlain by glacial drift occurs in the Wabash River valley wall immediately south of the region; hence it may be inferred that the drift is not very thick over much of this section.

The surface material ranging from 12 to 36 inches in depth is a clayey silty sand soil with low plasticity. The subsoil taken at test site No. 6 shows 75.7% of sand and 23.7% of fines. It has a LL of 18.4% and a PI of 3.2%. This silty sand soil has a CBR value of 12.0. The C-horizon reveals a decrease in sand (36.9%) and an increase of

fines (58.6%). From the LL and PI of 17.5% and 13.9% respectively the increment of clay is obvious. Furthermore the CBR value reduced drastically to 2.4. This phenomina may be inferred that a blanket of wind-blown sand or silt is deposited on top of the moraine. Henceforth, the B-horizon is much more sandy or silty than the parent material.

Test site No. 5, which is about 1.5 miles south from the previous site, indicates about the same situation. The increased amount of sand (52.6%) and silt in the C-horizon, however, could be attributed to the proximity of the Eel River channel.

Sandy-textured materials increase in prominence toward the east, and the increased proportion of granular material is reflected in more irregular topography. A broken, hilly region is encountered north of Logansport, which presists throughout most of the portion drained by the Eel River, and extends to the county's eastern boundary. The drainage basin of Twelve Mile Creek, the principal southward flowing tributaries of the Eel River, occupy a large portion of this region, much of which is underlain by granular deposits of sand and gravel. Of special interest is the system of parallel esker-like ridges. The materials within the ridges consist principally of well-graded, sands and gravels, with about 12% fine-grained materials passing the No. 200 sieve. These coarse granular-materials are considered representative of those encountered over a large region in this vicinity. Here, as in the western portion of the moraine, wind action has modified the surface configuration locally, to create longitudinal and transverse dunes.

The combination of granular soils, rugged topography, and excessively well-drained sands in this portion are responsible for a large proportion

of the uncultivated land within Cass County. Such materials belong to the Bellefontaine series, while the less granular sandy silts are ascribed to Metea and Miami Series. Clay-like materials are conspicously absent in the unweathered horizons of these upland soils.

The typical soil sample obtained at test site No. 6 contains a silty sand top soil about 12 inches deep, a clayey sand B-horizon, and a well-graded gravelly sand C-horizon. The B-horizon shows 9.2% gravel, 63.4% sand, and 27.4% fines with a LL of 30.4% and a PI of 11.6%. The gravel and sand contents increase to 34.0% and 55.1% respectively in the non-plastic C-horizon while the fines reduced to 10.9%. The CBR value of the parent material is 21.2 as compared to a value of 15.0 for the B-horizon. The subsoil is classified as SC and A-2-6 soil by the USCS and BPR classification respectively. SW-SM or A-1-B soil is designated as the parent material.

In the extreme northeastern corner of the county, the Packerton Moraine is rolling and hummocky. The surface materials include deposits of sand and pebbles, somewhat modified by wind action, interspersed with extensive areas of organic muck and peat. Distribution of the sands is somewhat irregular, and knolls of clean sand alternate randomly with those of sandy silts. The principal soil of this area is designated as Oshtemo sand by the agricultural soil survey.

Test site No. 11 is located in this area. It is chiefly sandy in texture throughout the soil profile. A fine silty sand A-horizon is about 8 inches in depth. The non-plastic B-horizon has 69.2% of sand 29.4% of fines and only 1.4% considered as gravel. Sand increases to 93% and fines decreases to 7.0% in the non-plastic C-horizon. Both the subsoil and the parent material are strong in load bearing capacity. They have CBR values of 20.0 and 21.8 respectively. The subsoil is

classified as SM and A-2-4 soil by the USCS and the BPR classification while the parent material is evaluated as poorly graded sand with silt (SP-SM) and fine sand (A-3) by the USCS and BPR specification.

(3) Morainic region between the Eel and Wabash River

This moraine iswedged between the Eel and Wabash Rivers and is believed to be the extension of the Union City Moraine from the south (10). It has an overall slightly rolling topography. However, severely dissected lands are found along the river valleys and a kettle-kame topography is shown on the southern portion of this region. Surface drainage systems are well developed on this moraine except in the area mapped as kettle-kame moraine. The elevation of this moraine is from 750 to 800 feet in the vicinity of the Wabash River.

The structure of this moraine is predominately till except in the kettle-kame area. From the location of the gravel pits shown on the map it is evident that more granular soil can be found in the kettle-kame area. The major soil in this region belongs to the Miami series with some Russell soil found on the western part of the area.

The granular soils described in the preceeding paragraphs show a variety of textures, ranging from clean, uniform wind-blown sands to dirty gravels. The wind-blown sands have been exploited extensively near Lake Cicott (see Figure 5) for use as bituminous filler.

An abundance of granular materials suitable for screened aggregates occur within the moraine. Many of the granular soils in the eastern portion, while unsuitable for use as concrete aggregates, will perform satisfactorily as base course and improved subgrade materials, as well as for road gravel for farm to market roads. Extensive exploitation

of these local materials is evidenced by the large number of gravel pits which occur throughout the county.

Ground Moraine

(1) Silty Clay Ground Moraine

The most extensive, and most typical of the ground moraines, often called till plains, occurring within this county is the Tipton Till Plain, which occupies most of the region south of the Wabash River. Except along its northern boundary, whose proximity to the Wabash River valley has favored strong gully dissection, the ground moraine appears as a vast, almost level expanse of remarkably uniform materials.

The region is drained by Pipe Creek, which skirts the northeastern corner, and Rock and Deer Creeks. The drainage system of Rock Creek is only weakly developed, while that of Deer Creek, near the southern boundary is moderately intrenched. Interrogation of farmers revealed that water wells often encounter limestone strata at a depth of about eighty feet. Bedrock is exposed in several localities fringing this area, notably in the valley of Big Pipe Creek, and in the valleys of Rock and Deer Creeks. Granular valley train deposits in stream terraces serve as local aggregate sources.

Soils of the Tipton Till Plain, for the most part, demonstrate more natural profile development than those in other parts of the county. Time and the absence of appreciable relief have favored development of somewhat plastic soils in the B-horizon.

By far the most widespread soil type is the Brookston silty-clay loam, followed by Fincastle and Fincastle-Crosby silt series.

Liquid limit and plastic index values of 20-25 and 6-12 respectively are reported as average values for the C-horizons of Tipton Till Plain by Belcher, Greeg and Woods (9); these values are confirmed by tests, (site No. 1 and No. 2) in connection with this investigation. Somewhat higher values of LL and PI occur in the B-horizon, which extends to depths averaging three to four feet.

The typical soil profile is found at test site No. 2. The silty A-horizon is about 6 inches thick. The B-horizon contains 13.9% sand and 84.6% of silt and clay. It has a LL of 36.8%, a PI of 19.9% and a CBR value of 10.0. It is classified as CL and A-6 (16) soil by the USCS and BPR system respectively. In the C-horizon, with sand increased to 49.7% and the fines reduced to 46.4%, the LL and the PI are both reduced to 23.0% and 8.0% respectively. However, the CBR value only changes slightly to a value of 8.9. This parent material is designated as SC and A-4 (2) soil by the above mentioned systems.

A fact of interest is the occurrence of windblown silt mantle overlying the glacial material immediately adjacent to the Wabash valley. At test site No. 1 the light uniformly textured silt extended to a depth of about two feet below which a weathered B-horizon was encountered in the underlying till. The silt mantle thins rapidly and disappears within

about a mile south of the river, which is likewise the approximate extent of gully penetration into the upland. A distinction should be recognized between windblown silt, or "loess", and the sandy silts of glacial origin which form the soil-parent materials of most of the fine-textured soils discussed herein.

Below the 6-inch silty top soil, the upper B_1-horizon taken between a depth of 6 to 24 inches, reveals the following data: 3.7% gravel, 21.5% sand, 74.8% fines, LL of 29.1%, PI of 12.1% and a CBR value of 4.9. The B_2-horizon taken from 24 inches to 60 inches, which is the weathered zone of the till, shows an increase of sand (41.8%), decrease of fines (55.8%) and a slight increase of LL (33.5%) and PI (14.4%) and a CBR value of 4.9. These B-horizon soils are essentially classified the same (CL by USCS and A-6 by BPR). The C-horizon taken below 60 inches indicates almost the same in grain size distribution but a slightly lower LL (27.9%) and PI (10.7%) than that of the B_2-horizon. However, the bearing capacity increases to a CBR value of 6.7. The parent soil is classified about the same as the B-horizon by the adopted systems.

(2) Sandy Clay Ground Moraine.

The sandy clay ground moraine is located in the intermoraine zone defined by the eastern limit of the Maxinkuckee Moraine and the northern boundary of the Packerton Moraine.

Due to the weak morainic features of the Maxinkuckee Moraine, the boundary between the terminal moraine and the ground moraine is not obvious. In fact, a ground observer would doubtless encounter substantial difficulties in attempting to define such a boundary; yet, with the aid of stereoscopic vision and aerial photo study a line has been drawn which defines a slight change in relief, and which agrees generally with the boundaries defined by Leverett and others. (7, 11).

The sandy clay ground moraine has a gently rolling or sag-swell topography. It changes into a very gently undulating land toward the north. Drainage within this region adjacent to the moraine is accomplished largely by surface runoff from the hill slopes to adjacent depressions, where the ponded water is dissipated by retarded downward percolation and evaporation. In the rest of this section a well-developed phantom drainage is evident. The preponderance of muck-filled kettle-holes is another important landscape of this region. Test data obtained from test sites Nos. 17, 9 and 10 scattered throughout this region indicate that the soils located west of Metea are essentially the same, consisting of extremely sandy silts and sandy clays of low plasticity while soils east of Metea are more clayey in texture.

The prominent soil in the western part of this region belongs to the Miami-Crosby-Brookston Catena. These soils contain a silty sand top soil about 10 inches in depth. The B-horizon taken from high ground at sites No. 9 and 17 contain

from 52.1% to 68.5% of sand and considerable amount of fines (43.1% to 30.4%). The LL and PI at site No. 9 has a value of 25.3% and 8.5% respectively, while at test site No. 17 the B-horizon is non-plastic. The subsoil at site No. 9 is classified as clayey sand (SC and A-4 (2) soil). While silty sand (SM, or A-2-4 soil) is designated as the B-horizon at site No. 17. The parent materials taken at both sites show the same amount of sand content (47.5% and 47.6%). However, a little more gravel (6.4% vs. 2.8% at site No. 9) and a little less of fines (46.1% vs. 49.6%) is found at site No. 17. The plasticity of both soils are about the same. However, the CBR value obtained at site 17 is a little better than that at site 9 (10.5 vs. 7.6). The parent soil at site No. 17 is classified as clayey sand (SC or A-4 (2)) soil while at site No. 9 it is evaluated as silty sand (SM-SC or A-4 (3) soil).

From the test data above, it is obvious that the soil found abutting the moraine is a little more granular in texture than in themoraine. The high sand content in the B-horizon is evident of wind-blown sand influence especially at the western portion of the region.

The soils found at site No. 10 located northeast of Metea show more clay content. The major soil series are Crosbyand Brookston. Beneath the 10 to 15 inches silty clay or sandy clay top soil the B-horizon contains 4.8% of gravel, 40.2% of sand and 55.0% of fines. It has a LL of 27.4%, PI of 10.3% and a CBR

value of 3.4. The subsoil is classified as silty clay, CL, or A-4 (4) soil. The parent materials reveals an increase of gravel (6.7%) and sand (44.3%) with a decrease of fines (49.0%). Plasticity as well as the CBR value are both increased (LL 25.6%, PI 12.1% and CBR 7.5) in the C-horizon. This soil is classified as sandy clay SC or A-6 (3) soil. The influence of wind-blown sand seems to be non-existant in this area.

(3) Sandy Ground Moraine

The principal sandy ground moraine lies in the northwestern corner of the county in the vicinity around Royal Center. This area is characterized by extremely flat topography with slopes that seldom attain 2% limit. The deposit appears to have been subjected to considerable amount of water reworking of materials. Surface runoff is retarded by such low slopes, so drainage is augmented to a considerable extent by man-made ditches (See Figure 3)

Soils of this region are designated as the Conover, Crosby and Brookston series. The surface soils are somewhat higher in organic material than those encountered in the moraine. A well-developed B-horizon is expected to yield mottled sandy, clayey silts and silty clays at depths between one and six feet. Typical glacial till, consisting of unassorted sand and silt with minor amounts of clay and gravel may occur.

Sampling at site No. 18 revealed considerable stratification of sands and clayey silts in the subsoil as well as a paucity of gravel-sized particles. Beneath about 12 inches of organic silty sand top soil the B-horizon taken from 1 to 3 ft. contains 71.6%

of sand, 26.2% of fines and 2.2% of gravel has a LL of 21.6%, a PI of 7.5% and CBR of 5.3. It is classified as the SC or A-2-4 soil. The parent material taken from 4 to 6 ft. shows an increase of gravel (6.4%) and fines (32.0%) but a decrease of sand (60.6%). However, the plastic properties reduced greatly to a non-plastic soil and the CBR increased to a value of 17.3 The soil in the C-horizon is evaluated as SM or A-2-4 soil. In view of the test results the higher sand content in the B-horizon may be attributed to the migrating wind-blown sands from the west or the water re-worked characteristic of this region.

Small areas along the glacial-fluvial channels in the ground morainic area, seem to be influenced by the water action considerably. The deposit is essentially the same as the surrounding ground moraine except that the surface or subsurface soil may contain a little more uniform material. On the higher topographic position a more sandy or silty soil prevails. However, along the depressions clayey or silty soils with considerable organic matter may be found.

Eskers

There are a few eskers within Cass County. The prominent ones about a mile in length are located southeast of Metea. The est are shattered north of Logansport, in the vicinity of Twelve Mile, north of New Waverly and southwest of Lewisburg. The typical esker land form can be identified from the airphoto readily. Gravel pits are located on almost every one of the eskers to exploit its granular material.

Kettle-Kames

The only typical kettle-kames area is located within the wedge-shaped area between the Eel and Wabash Rivers. It is mapped as part of the

extension of the Union City Moraine. The presence of muck bottomed gravel pits in this area illustrates the granular nature of the deposit.

WATER DEPOSITED MATERIALS

Owing to the enormous amount of melt-water flowing over Cass County during the late glacial stages, vast amounts of materials were deposited along the major drainage channels and upon the glacial-lacustrine plains. The various water deposits are discussed as follows.

Outwash plain

Along the western most border of the county, and extending eastward over distances ranging from one to four miles, lies the Cass County portion of the Kankakee lacustrine section. This important major physiographic subdivision occupies a large portion of northwestern Indiana, and includes deposits of extremely outwash character within the drainage basins of several major streams besides the Kankakee. The materials discussed in this section are properly ascribed to the basin of the Tippecanoe drainage system.

The materials in the Cass County portion of this region are basically very sandy outwash materials deposited by meltwaters from a zone of glacial ice-marginage, presumably in the vicinity of the Valparaiso Moraine. As glacial debris was dropped from the wasting ice at its outer edge, torrential sheets of meltwater accomplished subsequent sorting, so that coarser materials were deposited near the ice terminus, and finer-textured particles were deposited at distances from the front which depended on velocity of the water. This classification phenomenon is very well illustrated in the outwash materials of the area. As described previously in this report, a breach through the granular moraine in the vicinity of section 3, T27N R1W, (Figure 5), allowed the waters of Crooked Creek to

flow westward. As the moraine front was passed, the stream velocity decreased and the present coarse-textured deposits, including well rounded cobbles, gravel, and sand, were dropped. Farther westward, gravels with a greater preponderance of coarse sand are encountered, and finally materials of essentially sandy character were laid down. Silts and clays are almost lacking in the outwash materials on the rugged pitted outwash plain near the morainic front. (Figure 5). Farther westward the outwash terrace contain silty materials, and finally the outwash plain is obscured by encroaching eolian sands.

Much of the outwash terrain has a gently rolling, rounded surface. The coarse granular materials include members of the Fox, Bronson, and Homer series. Wyona and Lear series, the poorly drained equivalents of the series mentioned above, occupy much of the northwestern, "downslope" portion of this region. In the areas of high water table and poor drainage, man-made ditches are employed extensively which serve to lower the water table.

A typical sample in this area is taken at a gravel pit at site No. 15. The soil profile consists of a silty sand top soil of about 6 in. depth, a sandy clay B-horizon of 3 ft. in thickness and a sandy parent material. The B-horizon contains 25.4% of gravel, 43.9% of sand and 31.7% of fines. It has a LL of 32.4%, a PI of 16.5% and a CBR of 2.0. This falls in the classification of SC or A-2-6 soil. The parent material taken from 4 to 7 ft. shows an increase of gravel (31.8%) and sand (60.6) and a decrease of fines (8.2%). It has a non-plastic soil with a CBR of [illegible]. This parent soil is classified as well graded sand and sandy silt (SW-SM) or A-3 soil.

A local outwash plain is found within the Packerton Moraine east of Crooked Creek (Figure 5.) The smooth surface is broken by a few [illegible]

like hills. Surface drainage is void and a large gravel pit has been developed at the southwestern corner of the plain as shown in Figure 5. This plain is lower than the surrounding morainic upland. It seems likely that finer materials are washed into this basin from the adjacent uplands. Soils in this area belong to the Fox, Homer and Abington series.

Another local outwash plain is located south of Nevada. The surface is more pitted and numerous muck kettles are present in this area. Test site No. 7 is located in a gravel pit within the outwash plain. The B-horizon encountered about 6 inches below the silty sand top soil has 5.2% of gravel, 52.2% of sand and 42.6% of fines. The laboratory tests of the soil indicate a LL of 19.2% and a PI of 6.9%. The CBR value is 7.1. It is classified as SM-SC or A-4 (2) soil. The amount of gravel increases drastically in the C-horizon (62.6% gravel, 34.0% sand and 3.4% fines). This non-plastic parent material possess a high CBR value of 55.0. It is classified as poorly graded gravel, GP, or A-1-a soil.

Terraces

The valleys of the Wabash and Eel Rivers mark the sites of former glacial sluiceways, which presumably carried tremendous volumes of melt-water from the Pleistocene ice sheets. As the wasting ice freed its load of soil and rock, much of this detritus was transported within tributary drainage systems (by torrential meltwaters) and deposited within the sluiceways.

Along the Wabash and Eel valleys, numerous terraces occur at various levels between the streams and uplands. Generalities are difficult to make concerning either materials or surface expression. Some consist of coarse granular materials of level to gently rolling form; others

demonstrate undulating surfaces modified by wind action; and many are formed of limestone rock capped by a veneer of gravel or alluvium.

Terraces of clean, water-worked sands and gravels occupy positions intermediate between floodplains and uplands along the Kel and Wabash Rivers. These "Valley train" deposits are entirely similar in texture, drainage, and relief to outwash plain deposits, except of course in their proximity to the major streams. Gully development if present, is incipient, and only the larger streams descending from the uplands have sufficient cutting power to develop channels across the terraces. A useful criterion in recognition of these granular terrace deposits on air-photos is the disappearance, at the periphery, of gullies which descend from the uplands.

The principal soils are those of the Fox series. Such series are characterized by brown, friable topsoil having minimal clay-like properties, overlying clean, stratified sands and gravels at depths ranging from three to four feet. Such deposits are excellent sources of borrow and subgrade material.

A typical test site for the terrace is located at Site No. 4. A sandy silty top soil of about 6 inches is formed on the surface of the terrace. The B-horizon taken from 6 to 36 inches contains 11.5% of gravel, 65.8% of sand and 22.7% of fines. The soil is somewhat plastic, with LL of 25.7% and PI of 12.8%. The test shows a very low CBR value (0.90) and is classified as SC or A-2-6 soil. In the C-horizon, the gravel fraction increases to 41.6%, sand and fines both decrease to 57.2% and 1.2% respectively. The soil is non-plastic and the CBR value increased to 37.5. The parent material is evaluated as poorly graded sand, SP or A-1-b soil.

Another test site (No. 13) located near the big bend of Crooked Creek (Figure 5) shows a more granular subsoil and parent material. The B-horizon is classified the same as that of No. 4. However, the non-plastic parent material (53.2% gravel, 41.1% sand and 5.7% fines) is classified as well-graded gravel and gravelly silt or A-1-a soil.

The soil at test site No. 3 located near the outlet of Big Pipe Creek contains more fines and less gravel than the materials of the previous sites. This local variation could be attributed to the proximity of a small stream draining the silty clay ground moraine to the south. The subsoil is classified as CL or A-7-6 (7) soil while the parent material is designated as SM or A-2-4 soil.

Narrow and small discontinuous terraces are found along major tributaries of Eel and Wabash Rivers especially along the Crooked Creek, Big Pipe Creek and Twelve Mile Creeks. The soils are essentially the same as those found on the Eel and Wabash Rivers.

Recent Alluvium

Practically all the drainage channels possess recent alluvial plains; however, only those of considerable size are shown on the soils map, because of the scale limitation.

Immediately adjacent to the Wabash and Eel Rivers, interstratified deposits of alluvial sands and silts occur. These alluvial materials are principally the result of seasonal flooding of the streams, and may show rather wide variation in texture and depth of profile, which are functions of the size and gradient of the streams. The soils are mapped principally as Genessee and Eel Series on agricultural soils maps, the latter occurring in positions where retarded drainage has favored development of a somewhat organic surface horizon. The Genessee

soils and the Zal series to a slightly lesser extent, are well-drained although subject to flooding.

The substrata along the Wabash River are perhaps more important in an engineering sense. Along a large portion of its course through Cass County, the river flows over a limestone floor. Outcroppings of bedrock are in evidence throughout the valley; both along the river banks and in adjacent rock defended terraces. Testimony to this fact occurs in the several limestone quarries operating in this region.

Many of the "first terraces" along the Wabash are of such a nature, and a peculiar landscape results from the presence of numerous limestone "stacks" and mound-like outcroppings. If soil exists at all on such features, it develops as the Milton, Millsdale, or Farmington series. The latter soil is described as having developed on thin glacial drift, while the former two series are ascribed to thin glacio-fluvial deposits, but the presence of bedrock near the surface negates the importance of soil texture in such situations. The intervening depressed flats contain heavy textured and poorly drained soils which extend to bedrock within about three feet ofthe surface.

Somewhat larger masses of limestone occurring within the valley, have a tabular surface on level terrain and the surface materials consist of glacio-fluvial gravels. These features, illustrated well by those in section 32, T27N R1W, are unique in their separation from the adjacent uplands. An even larger feature of this type occurs immediately south of New Waverly, near the eastern county line.

WIND DEPOSITED MATERIAL

There are two types of wind depositied materials in Cass County.

Loess

The loess deposits which occur along both banks of the Eel and Wabash Rivers extend about a mile or two into the uplands and have a maximum depth of 3 ft. They are designated by the agricultural soil survey as Russell soil. The ground moraine that is located south of the Wabash River also shows the influence of loess deposit. The major soil in this till plain area belongs to the Fincastle series. Since the deposit is not appreciably thick they are not mapped as loess deposit on the attached soils map.

Sand

The major wind deposited material in Cass County is sand which occurs over a considerable area on the western part of the county.

Perhaps the most striking terrain in the county is that of the sand dune section along the western boundary. The dunes, are of the transverse type, with a somewhat irregular, curvilinear pattern, and may attain heights of 40 feet. The major dunes are somewhat stabilized by vegetation, but land-use practices which disturb the surface cover may initiate severe "blow-out" erosion. Large dunes occur in the extreme northwestern corner of the county and in the vicinity of Lake Cicott. Those around Lake Cicott have been exploited extensively as sources of mineral filler for bituminous mixes.

The excessive drainage within these uniformly textured sands favors somewhat retarded weathering; hence, soil profile development is poor or non existant. A typical dune soil profile is that of the Plainfield series, which consists of a very shallow silty sand with humus

topsoil overlying clean buff sand of considerable depth. Occasionally discoloration due to iron oxide or some other source may extend to a depth of several feet, but this is insignificant in the consideration of the engineering properties of the material.

A typical sample was obtained at test site No. 14 indicated on the map. The B-horizon taken from 6 to 43 inches contains 86.5% of sand and 13.5% of fines. The C-horizon taken from 43 to 60 inches shows 92.3% of sand and 7.7% of fines. Both are non-plastic soils and the sands are remarkably uniform in size. The CBR value increases from 26.6 for the B-horizon to a value of 37.4 for the C-horizon. The subsoil is classified as SM or A-2-4 soil while the parent material is considered as poorly graded sand, SP-SM or A-3 soil.

In the incipient dune area, the soil is essentially the same as in the true dune area, but the thickness of the wind-blown deposit is reduced and the influence of the underlying material is more pronounced. The airphoto pattern (Figure 5) shows a retarded interior drainage characteristic. Judging from the proximity of the moraine to the east and the encroaching sand dune from the west it is evident that the incipient dunes overlay glacial drift materials.

MISCELLANEOUS FORMATIONS

Muck and Peat

Large areas of muck and/or peat occur throughout the county but primarily in the northern half. Airphoto interpretation is the most convenient method to locate these troublesome areas as the dark photo tone and the depressed position of the muck and peat pockets are easily delineated.

Concentrations of these deposits are found in the northeastern corner of Cass County and along the glacial-fluvial channels especially in the vicinity of Crooked Creek. These muck or peat deposits range from superficial deposits of relatively minor extent and depth to deposits several hundred acres in size and as much as a hundred feet in depth. Each deposit should be field investigated for design purposes.

Highly Organic Top Soil

Depressed areas where internal drainage is somewhat retarded by the high ground water table give rise to the accumulation of a considerable amount of organic topsoil. There are a large number of such areas. Most of them are located within the outwash plain and the sand dune region along the western border. Others are found along the glacio-fluvial channels or as isolated depressions on the ground moraines. The parent materials underlying the organic top soil are essentially the same as those of the surrounding area. The soil in general is designated as Kokomo soil on agricultural soil surveys. Where large areas exist, an organic symbol is used on the attached map to delineate possible problem soil areas.

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All airphotos used in connection with the preparation of this report automatically carry the following credit line: "Photographed for Bureau of Public Roads, Stabilization Service, Performance and Aerial Photography Division, U.S. ..."

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SOIL—TESTING DATA

SITE	HORIZON	DEPTH IN FT.	GRAIN SIZE DISTRIBUTION: GRAVEL % ON #10	COARSE SAND % #10–#60	FINE SAND % #60–#200	SILT & CLAY % LESS #200	LIQUID LIMIT	PLASTIC INDEX	O.M.C FOR STAND PROCTOR TEST	MAX DRY WEIGHT FROM STD. PROCTOR TEST	C B R.	MOISTURE CONTENT OF C B R TEST	UNIFIED CLASSIFICATION	B P R CLASSIFICATION
1	B	1/2 – 2	3.7	9.6	11.9	74.8	29.1	12.1	14.8	112.6	4.6[4]	15.2	CL	A-6 (16)
	B	2 – 5	2.4	19.1	22.7	55.8	33.5	14.4	16.5	110.4	4.9[4]	14.5	CL	A-6(6)
	C	5 –	5.1	19.3	23.2	52.4	27.9	10.7	12.7	117.9	6.7[4]	12.0	CL	A-6(4)
2	B	1/2 – 3	1.5	6.6	7.3	84.6	36.8	19.9	16.6	109.5	10.0[3]	16.4	CL	A-6(16)
	C	3 – 6	3.9	26.2	23.5	46.4	23.0	8.0	12.5	118.2	8.9[4]	11.9	SC	A-4(2)
3	B	1/2 – 1 1/2	11.4	11.5	14.7	62.4	44.7	26.6	19.1	107.0	3.4[4]	20.2	CL	A-7-6(7)
		4 – 6	3.0	24.4	37.9	34.7	NP	NP	8.6	130.0	13.6[3]	9.8	SM	A-2-4
4	B	1/2 – 3	11.5	36.7	29.1	22.7	25.7	12.8	15.0	114.9	0.9[4]	15.3	SC	A-2-6
	C	3 – 6	41.6	51.7	5.5	1.2	NP	NP	1.8	124.6	37.5[2]	0.84	SP	A-1-6
5	C	2 1/2 – 3 1/2	6.9	24.4	37.9	40.5	18.8	5.2	10.9	124.0	15[4]	12.2	SM-SC	A-4 (1)
6	B	1 1/2 – 2 1/2	9.2	35.0	28.4	27.4	30.4	11.6	12.3	119.0	15.0[3]	12.6	SC	A-2-6
	C	2 1/2 – 3 1/2	34.0	47.4	7.7	10.9	NP	NP	9.0	144.8	21.2[2]	7.6	SW-SM	A-1-6
7	B	1 1/2 – 2 1/2	5.2	20.6	31.6	42.6	19.2	6.9	11.2	125.6	7.1[2]	11.8	SM-SC	A-4 (2)
	C	2 1/2 – 3 1/2	62.6	27.3	6.7	3.4	NP	NP	12.0	119.2	55.0[3]	11.2	GP	A-1-a
8	B	1 1/2 – 2 1/2	0.6	27.3	48.4	23.7	18.4	3.2	12.0	119.2	12.0[3]	12.5	SM	A-2-4
	C	2 1/2 – 3 1/2	4.5	17.5	19.4	58.6	27.5	3.9	13.2	117.0	2.4[4]	8.6	CL	A-6(7)
9	B	1 1/2 – 2 1/2	4.8	19.0	33.1	43.1	25.3	8.5	14.7	117.2	5.1[3]	14.6	SC	A-4(2)
	C	2 1/2 – 3 1/2	2.9	20.1	27.5	49.5	18.7	6.0	9.7	129.0	76[3]	9.7	SM-SC	A-4(3)
10	B	1 1/2 – 2 1/2	4.8	14.6	25.6	55.0	27.4	10.3	16.0	112.2	3.4[4]	18.9	CL	A-6(4)
	C	2 1/2 – 3 1/2	6.7	16.1	26.2	49.0	25.6	10.1	12.0	124.0	7.5[3]	13.0	SC	A-6(3)
11	B	1 1/2 – 2 1/2	1.4	24.5	44.7	29.4	NP	NP	10.2	119.6	20.0[1]	9.4	SM	A-2-4
	C	2 1/2 – 3 1/2	0	35.2	57.8	7.0	NP	NP	11.0	114.0	21.8[3]	11.5	SP-SM	A-3
12	B	2 – 4	9.4	19.5	24.9	46.2	23.6	5.8	12.3	118.4	9.8[4]	12.2	SM-SC	A-4(2)
	C	6	9.2	27.1	27.3	36.4	15.2	3.0	8.6	126.1	4.6[4]	9.7	SM	A-4
13	B	1 1/2	25.4	36.9	17.1	18.6	24.9	11.3	13.6	122.1	8.6[3]	13.2	SC	A-2-6
	C	1 1/2 – 3	53.2	35.5	5.6	5.7	NP	NP	9.6	131.0	24.8	9.0	GW-GM	A- a
14	B	1/2 – 4	0	28.1	58.4	13.5	NP	NP	10.1	13 -	26.6[1]	9.2	SM	A-2-4
	C	4 – 6	0	29.5	62.8	7.7	NP	NP	11.2	115.0	37.4[3]	10.6	SP-SM	A-3
15	B	1/2 – 3	25.4	22.1	21.8	30.7	32.4	16.5	14.8	113.2	2.0[3]	16.6	SC	A-2-6(1)
	C	4 – 6	31.8	47.2	12.8	8.2	NP	NP	7.1	122.5	8.0[4]	11.5	SW-SM	A-3
16	B	2 – 4	6.1	17.7	30.4	45.8	26.4	13.1	12.4	119.1	8.6[4]	12.8	SC	A-6 (3)
	C	4 – 6	5.5	17.0	28.6	48.9	15.7	2.0	8.5	128.2	22.4[2]	8.5	SM	A-4 (3)
17	B	1 – 7	1.1	21.2	47.3	30.4	NP	NP	8.6	114.1	6.2[3]	8.7	SM	A-2-4
	C	7 – 10	6.4	18.3	29.2	46.1	22.6	7.6	13.0	110.4	0.5[5]	11.6	SC	A-4 (2)
18	B	1 – 3	2.2	22.7	46.9	28.2	21.9	7.5	12.2	119.7	5.3[4]	11.7	SC	A-2-4
	C	4 – 6	6.4	23.5	37.1	34.0	NP	NP	8.5	129.0	17.3[3]	8.6	SM	A-2-4

C B R. NOTATION
1 WITH SURCHARGE OF 10 LBS
2 WITH SURCHARGE OF 15 LBS
3 WITH SURCHARGE OF 25 LBS
4 WITH SURCHARGE OF 25 LBS
5 WITH SURCHARGE OF 30 LBS

PREPARED BY R BECKER, UNDER SUPERVISION OF PT YEH

ENGINEERING SOILS MAP
CASS COUNTY
INDIANA

PREPARED FROM

1938 AAA AERIAL PHOTOGRAPHS

BY

JOINT HIGHWAY RESEARCH PROJECT

AT

PURDUE UNIVERSITY

1959

SCALE OF MILES

1 0 1 2 3 4

POLYCO

LEGEND

PARENT MATERIALS (GROUPED ACCORDING TO LAND FORM AND ORIGIN)

- MORAINE
- KETTLE KAME MORAINE
- GROUND MORAINE
- OUTWASH PLAIN
- VALLEY TRAIN TERRACE
- SAND DUNES
- SAND WITH INCIPIENT DUNE DEVELOPMENT
- THIN TERRACE ON LIMESTONE
- SAND DUNES ON LIMESTONE
- DRIFT ON LIMESTONE
- LIMESTONE
- PEAT & MUCK
- ESKER
- ALLUVIAL PLAIN, RECENT

MISCELLANEOUS

- GRAVEL PIT
- SAND PIT
- ROCK QUARRY
- LAKE OR POND
- HIGHLY ORGANIC TOP SOIL

TEXTURAL SYMBOLS (SUPERIMPOSED ON PARENT MATERIAL SYMBOLS TO SHOW RELATIVE COMPOSITION)

- GRAVEL
- SAND
- SILT
- CLAY

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SCALE OF MILES

1 0 1 2 3 4

POLYCONIC PROJECTION

DRAWN BY L A BELLAMY & F DONALDSON